

UNITED STATES NAVAL ACADEMY  
DIVISION OF  
ENGINEERING AND WEAPONS  
ANNAPOLIS, MARYLAND

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**CALIBRATION OF  
PIEZOELECTRIC ACCELEROMETERS  
AND FORCE TRANSDUCERS**

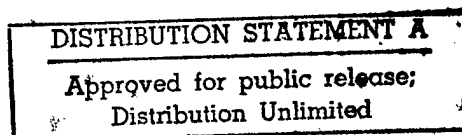
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## **ABSTRACT**

This paper presents the calibration data for several piezoelectric accelerometers and force transducers. The work was required for NSWC and was conducted under document number N00167-95-WR-50167.

## **INTRODUCTION**

This paper presents the calibration results for several piezoelectric accelerometers and force transducers. The work was required for NSWC and was conducted under document number N00167-95-WR-50167. Calibration accuracy is estimated at  $\pm 0.5$  dB in the frequency range noted in the tables.

Some of the transducers were new and previously unused. These are identified <sup>N</sup> in the tables. Old transducers have no identifying superscript.

The calibration was primarily against a 20.00 lb  $\pm 0.01$  lb steel block suspended on steel wires. A variety of excitation methods was used, including random and steady state harmonic. The tables identify which tests were used, and the frequency range in which the calibration is valid.

Initial calibration was on October 28, 1994, but values have recently been confirmed for this report.

Dr. Colin P. Ratcliffe

June 1995

### CALIBRATION OF WILCOXON F4 EXCITER INBUILT IMPEDANCE HEAD

Frequency range:	750-1250 Hz
Calibration frequency:	1 kHz.
Excitation:	PRBS
Amplifier Model 456 gain for force set to:	0dB
Amplifier Model 456 gain for acceleration set to:	20dB

Enter the following V/[EU] values in HP3562A:

Force gauge	97.2 mV/N
Accelerometer	160.5 mV/[m/s <sup>2</sup> ]

### CALIBRATION OF WILCOXON F4 EXCITER EXTERNAL IMPEDANCE HEAD

*note that calibration was outside tolerance for this instrument*

Frequency range:	750-1250 Hz
Calibration frequency:	1 kHz.
Excitation:	PRBS
Amplifier Model 456 gain for force set to:	0dB
Amplifier Model 456 gain for acceleration set to:	20dB

Enter the following V/[EU] values in HP3562A:

Force gauge	20.0 mV/N
Accelerometer	6.0 mV/[m/s <sup>2</sup> ]

### CALIBRATION OF WILCOXON F10 EXCITER IMPEDANCE HEAD

Calibration frequency: 1 kHz.  
Excitation: steady state  
Amplifier Model 456 gain for force set to: 20dB  
Amplifier Model 456 gain for acceleration set to: 40dB  
Enter the following values in Solartron 1250/54:  
Force gauge: 0.0099 V/N  
Accelerometer: 1.26 V/[m/s<sup>2</sup>]

### CALIBRATION OF PCB ICP ACCELEROMETERS

Frequency range: 750-1250 Hz  
Calibration frequency: 1 kHz.  
Excitation: PRBS  
PCB ICP gain: ×10

Enter these V/[EU] values in HP3562A:

N309A/5136	5.772 mV/[m/s <sup>2</sup> ]
N309A/5137	5.641 mV/[m/s <sup>2</sup> ]
N309A/5138	5.987 mV/[m/s <sup>2</sup> ]
N309A/5139	5.855 mV/[m/s <sup>2</sup> ]
N305A12/11873	uncalibrated

### CALIBRATION OF COLUMBIA CHARGE ACCELEROMETERS

Frequency range: 750-1250 Hz

Calibration frequency: 1 kHz.

Excitation: PRBS

Charge Amplifier Type 2635 gain:  $\times 100$

HP3562A V/[EU] entry: 0.1 V/[EU]

Enter the following values on the 2635 amplifier:

	(manufacturer)	(this calibration)
N3030/1000	6.51 pC/[m/s <sup>2</sup> ]	6.04 pC/[m/s <sup>2</sup> ]
N3030/1029	6.61 pC/[m/s <sup>2</sup> ]	5.89 pC/[m/s <sup>2</sup> ]
N3025/794	7.04 pC/[m/s <sup>2</sup> ]	6.51 pC/[m/s <sup>2</sup> ]
N3025/793	7.15 pC/[m/s <sup>2</sup> ]	6.59 pC/[m/s <sup>2</sup> ]

### CALIBRATION OF COLUMBIA CHARGE ACCELEROMETERS

Calibration frequency: 1 kHz.

Excitation: steady state

Accelerometers referenced to: Accelerometer 309A/5137

Charge Amplifier Type 2635 gain:  $\times 100$

Solartron 1250/54 entry: 0.1 V/[EU]

Enter the following values on the 2635 amplifier:

	(manufacturer)	(this calibration)
N3030/1000	6.51 pC/[m/s <sup>2</sup> ]	6.28 pC/[m/s <sup>2</sup> ]
N3030/1029z	6.61 pC/[m/s <sup>2</sup> ]	6.10 pC/[m/s <sup>2</sup> ]
N3025/794	7.04 pC/[m/s <sup>2</sup> ]	6.80 pC/[m/s <sup>2</sup> ]
N3025/793	7.15 pC/[m/s <sup>2</sup> ]	7.02 pC/[m/s <sup>2</sup> ]

### CALIBRATION OF FORCE TRANSDUCERS

Frequency range: 750-1250 Hz

Calibration frequency: 1 kHz.

Excitation: PRBS

Charge Amplifier Type 2635 gain:  $\times 1$

HP3562A entry: 1.0 mV/[EU]

Enter the following values on the 2635 amplifier:

9071A/520137 3.99 pC/N

217A/157 2.45 pC/N

recalibrated 6/21/95

9071A/520137 4.15 pC/N

217A/157 1.84 pC/N



## COMPUTER DATA FILES IN DIRECTORY C:\DTRC\PROJ\_ST\CALIBRATION

These files contain the raw data used for determining calibration values. References to the "device" mean the steel fitting manufactured by NSWCC and used to put an accelerometer in-line with the exciter head.

Force gauge for F4 with inbuilt impedance head & accelerometer 309A/5137

750-1250 Hz      001Z001Z

0-5 kHz          002Z002Z

Force gauge and accelerometer for F4 with inbuilt impedance head

750-1250 Hz      003Z003Z

0-5 kHz          004Z004Z

Force gauge for F4 with external impedance head & Accelerometer 309A/5137

750-1250 Hz      005Z005Z

0-5 kHz          006Z006Z

Force gauge and accelerometer for F4 with external impedance head

750-1250 Hz      007Z007Z

0-5 kHz          008Z008Z

F10 accelerometer referenced to Accelerometer 309A/5139

30-4000 Hz      009Z009Z

F10 force gauge calibration (20 lb)

30-4000 Hz      010Z010Z      referenced to 309A/5139

30-4000 Hz      010Z011Z      referenced to F10 accelerometer

calibration with "the device" on the F10 (vertical)

referenced to 3030/1029	30-4000 Hz
309A/5139	012Z012Z
F10 accelerometer	012Z013Z
referenced to 309a/5139	30-4000 Hz
F10 accelerometer	013Z013Z
3030/1029	013z014Z

Calibration with "the device" on the F10 (vertical), plus 20lb block - Columbia  
accelerometer next to the F10, other two on top of 20lb block - referenced to the F10  
force transducer - 30-4000 Hz

309A/5139 (top of block)	015Z015Z
F10 accelerometer	015Z016Z
3030/1029 (on F10)	015Z017Z
3025/794 (top of block)	015Z018Z

calibration with "the device" on the F10 (vertical), plus 20lb block - Columbia  
accelerometer furthest from the F10, other two on top of 20lb block - referenced to the  
F10 force transducer - 30-4000 Hz

309A/5139 (top of block)	019Z019Z
F10 accelerometer	019Z020Z
3030/1029 (on F10)	019Z021Z
3025/794 (top of block)	019Z022Z

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